

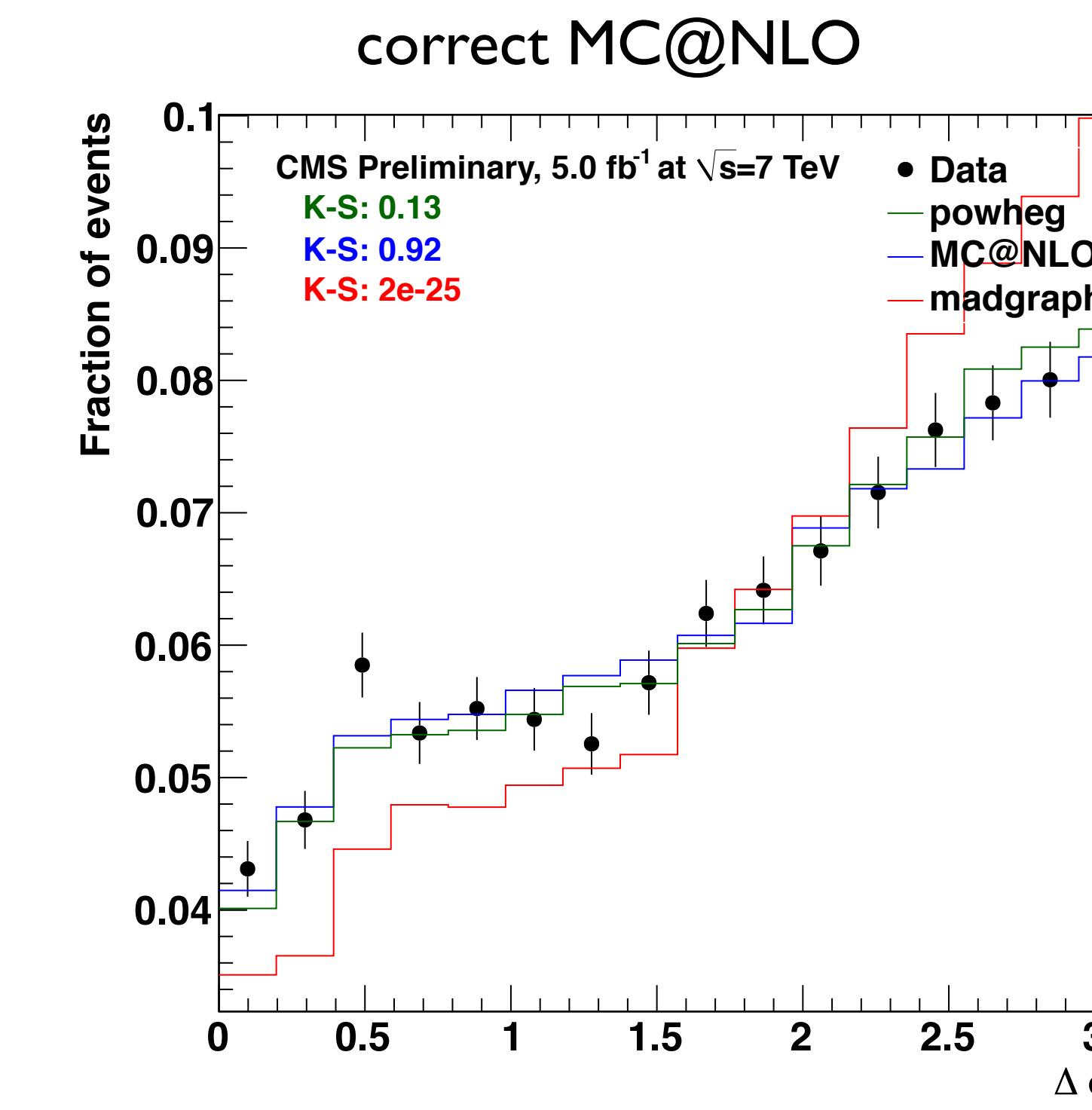
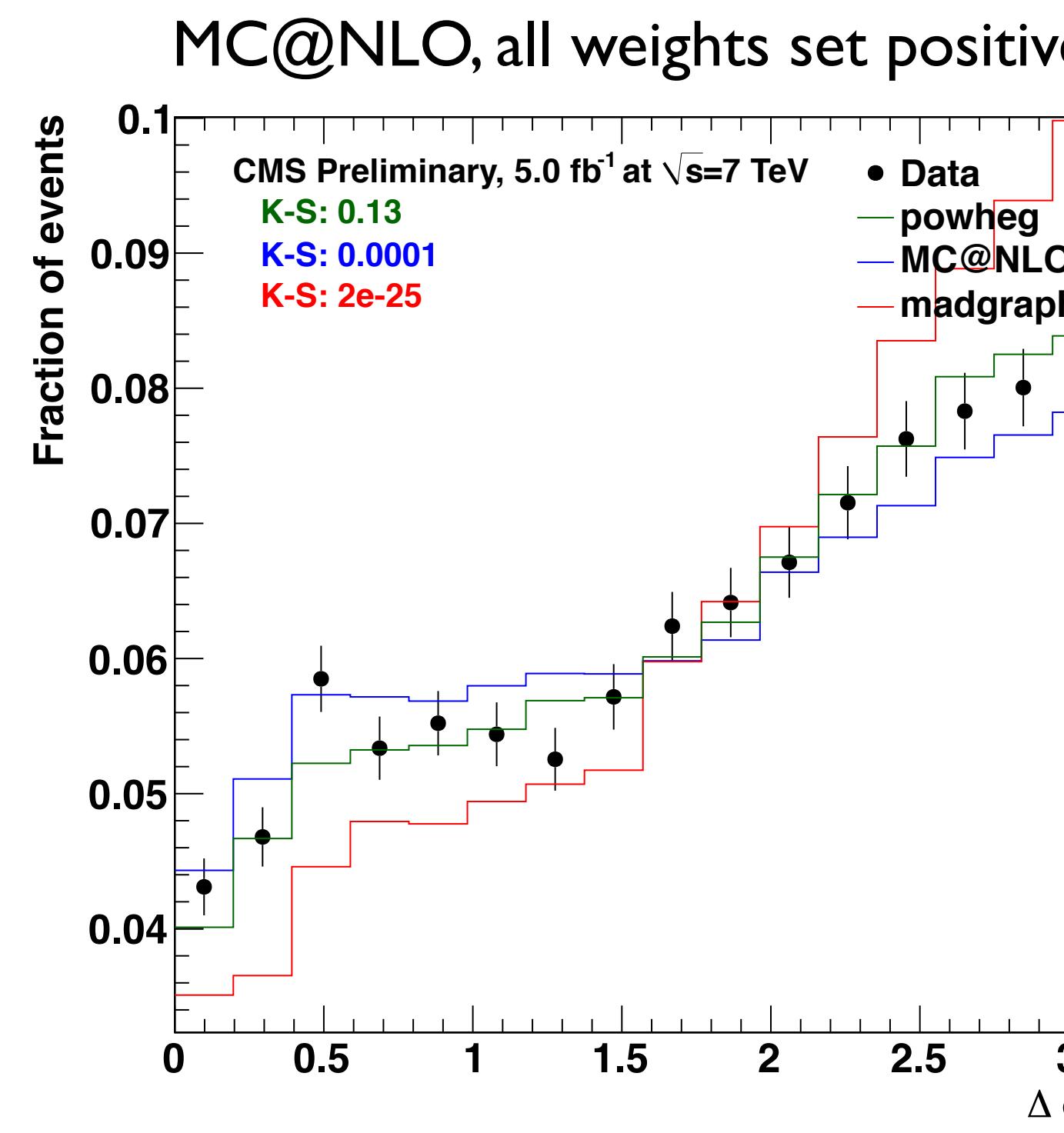
MC@NLO and powheg comparison: $\Delta\phi_{i\bar{i}}$ distributions

Introduction

- Found a bug in our code 2 weeks ago that was causing weights for all MC@NLO events to be set positive
- After fixing this we investigated the residual differences between MC@NLO and powheg

Data-MC comparison (preselection)

- Bug in our code caused weights for all MC@NLO events to be set positive
- Plots show data compared to sum of MC (ttbar+bkg) using 3 different samples for the dileptonic ttbar component, with the bug affecting MC@NLO (left) and after it was fixed (right)
 - all histograms are normalised to unity
- Significant improvement in the agreement between MC@NLO and data at the preselection level
- Disagreement between powheg and MC@NLO much reduced, but still present (larger asymmetry in powheg)

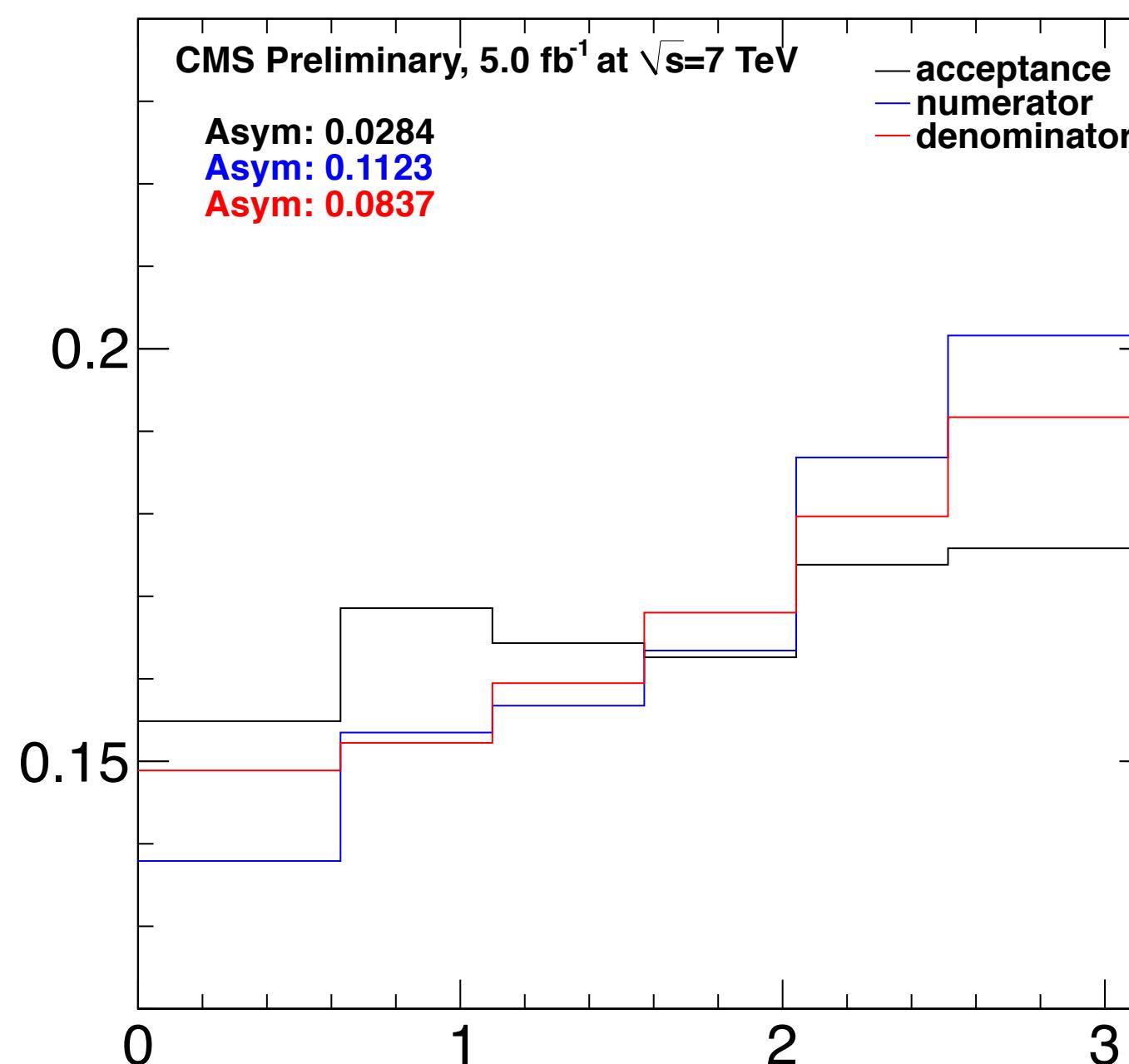


$$\text{Asym} = (\mathbf{N}_R - \mathbf{N}_L) / (\mathbf{N}_R + \mathbf{N}_L)$$
$$\text{Asym}_{\text{powheg}} = 0.171$$
$$\text{Asym}_{\text{MC@NLO}} = 0.151$$
$$\text{Asym}_{\text{madgraph}} = 0.272$$

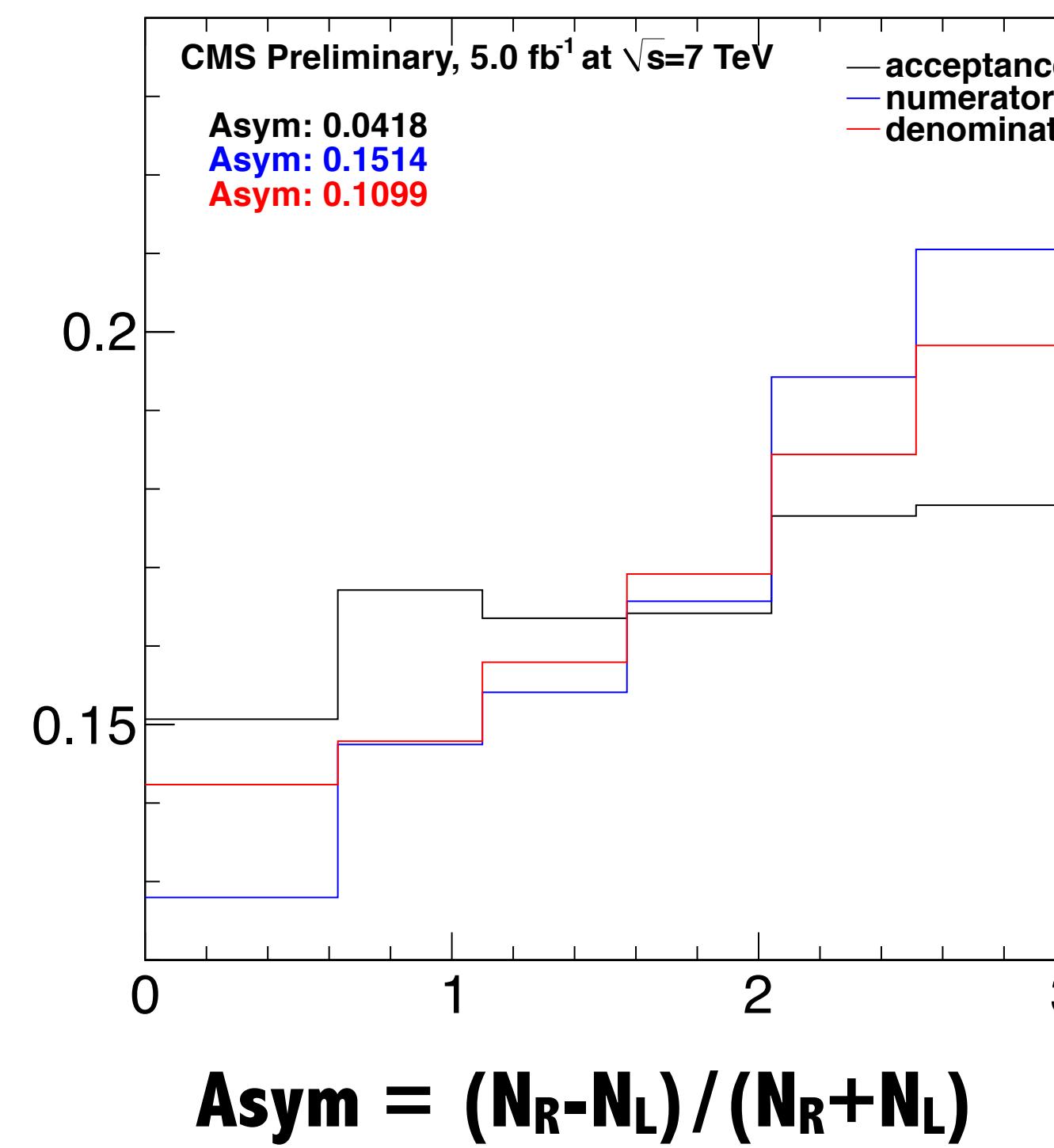
Comparison before cuts, and acceptance

- These plots show pure dileptonic ttbar MC: **numerator (preselection)** and **denominator (no cuts)** histograms, and resulting acceptance histograms (again all normalised to 1). Note, numerator distributions here correspond to distributions on the last slide, but now without background.
- With correct weighting, MC@NLO denominator asym is close to powheg, but numerator asym not quite in agreement (as we saw last slide).

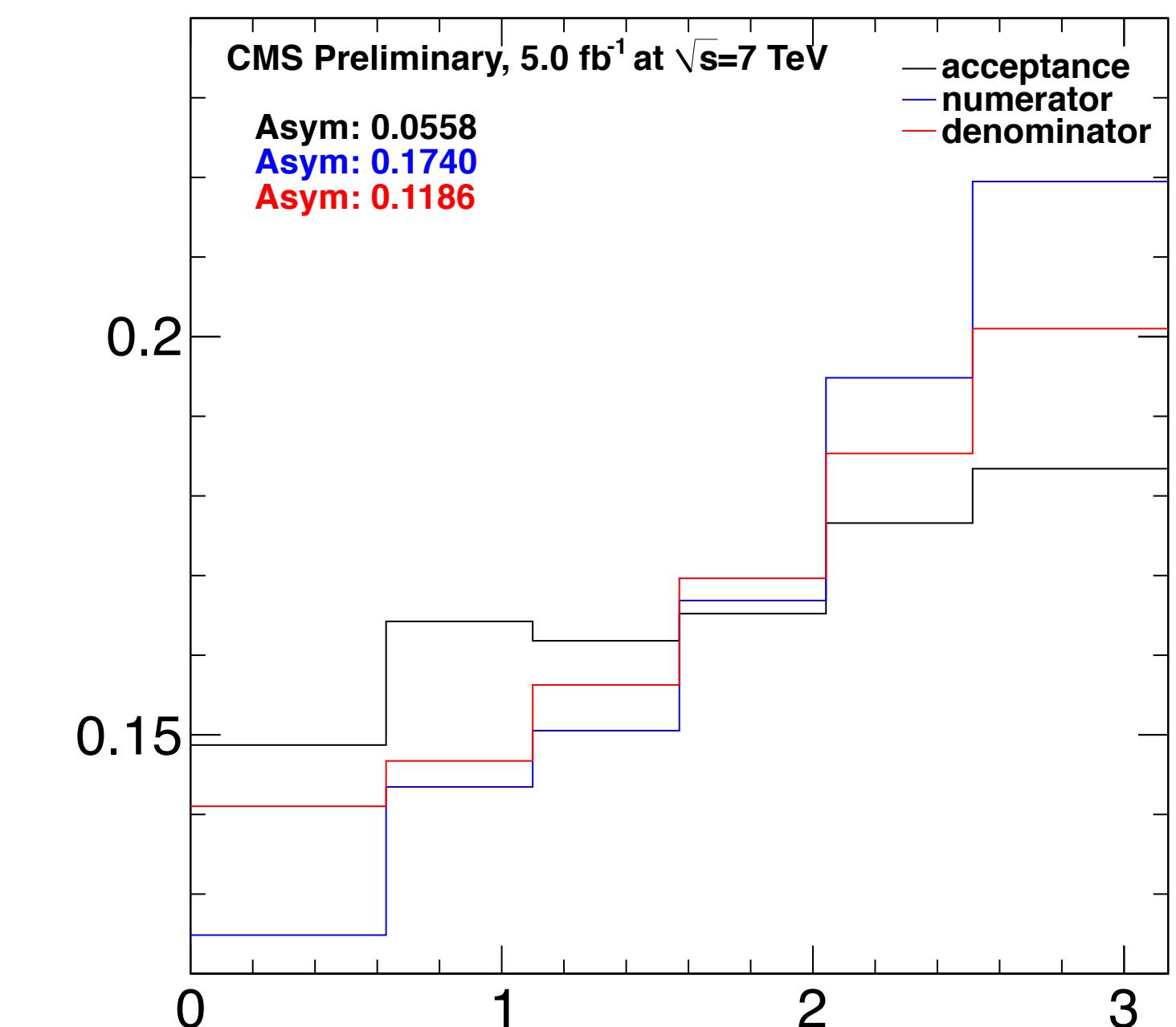
MC@NLO, all weights set positive



correct MC@NLO



powheg



$$\text{Asym} = (N_R - N_L) / (N_R + N_L)$$

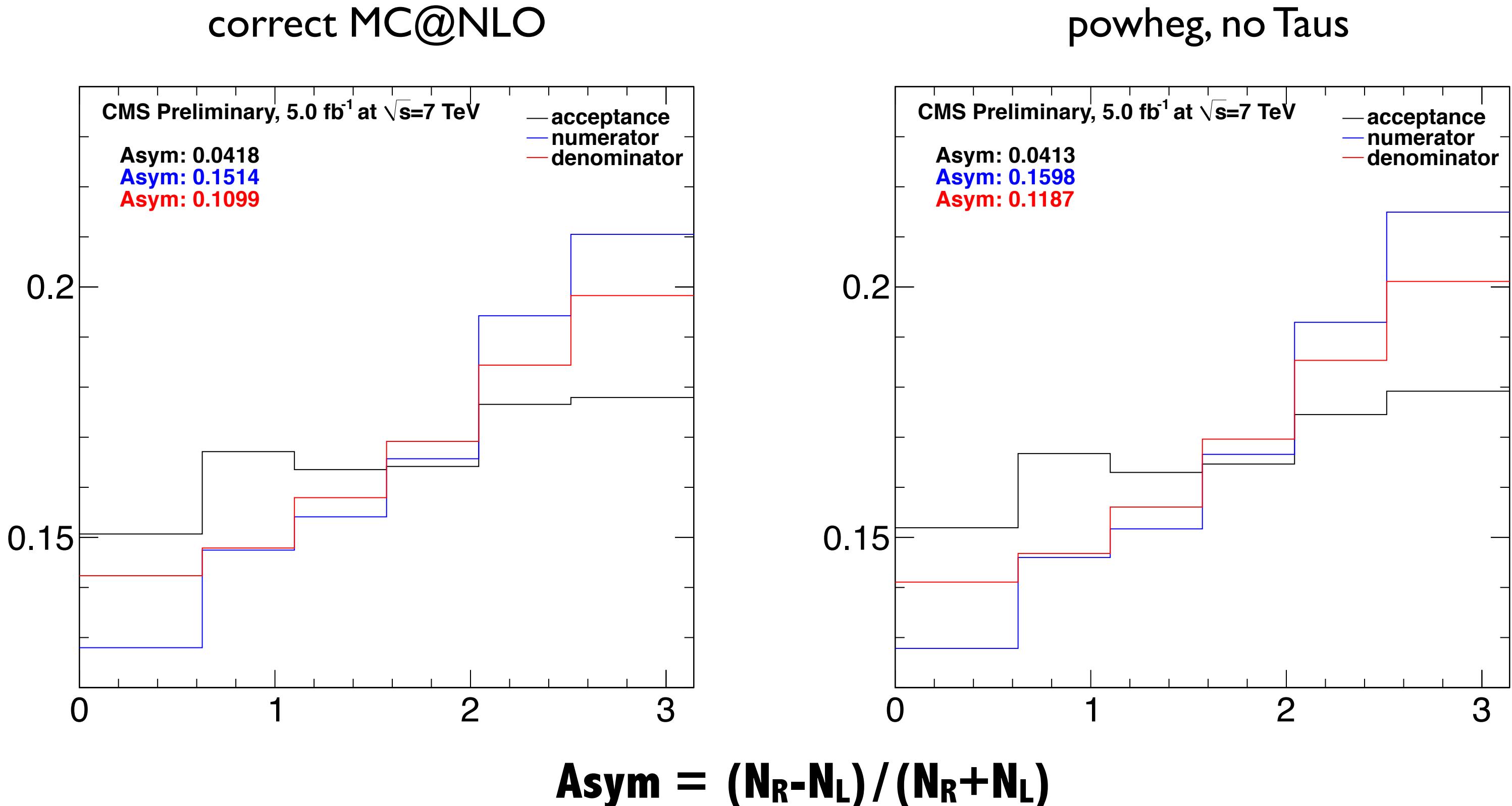
Comparison without taus

- It turns out that “leptonGenpCount_lepTauDecays()” in our code cannot identify leptonic tau decays in MC@NLO
 - `cms2.genps_lepdaughter_id()[jj].size() = 0` for all taus; result is that events with taus are omitted from MC@NLO histograms
- Compare MC@NLO to powheg without taus (otherwise same as previous slide): numerators (and thus acceptance) now similar
 - note, our current crude “modeling” systematic for $\Delta\phi_{\parallel}$ comes mostly from the difference in acceptance asymmetries

dumpDocLines() shows no tau daughters for MC@NLO:

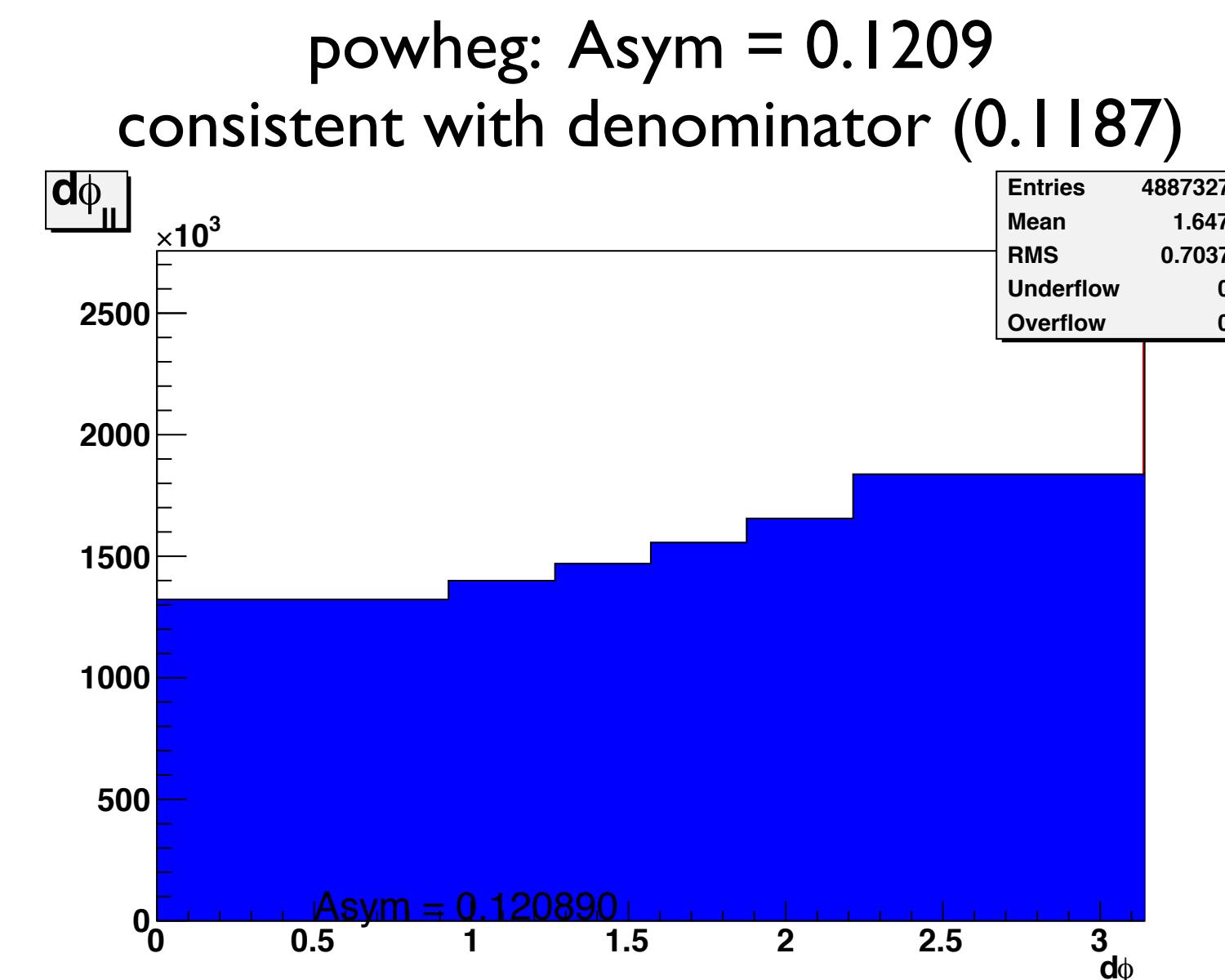
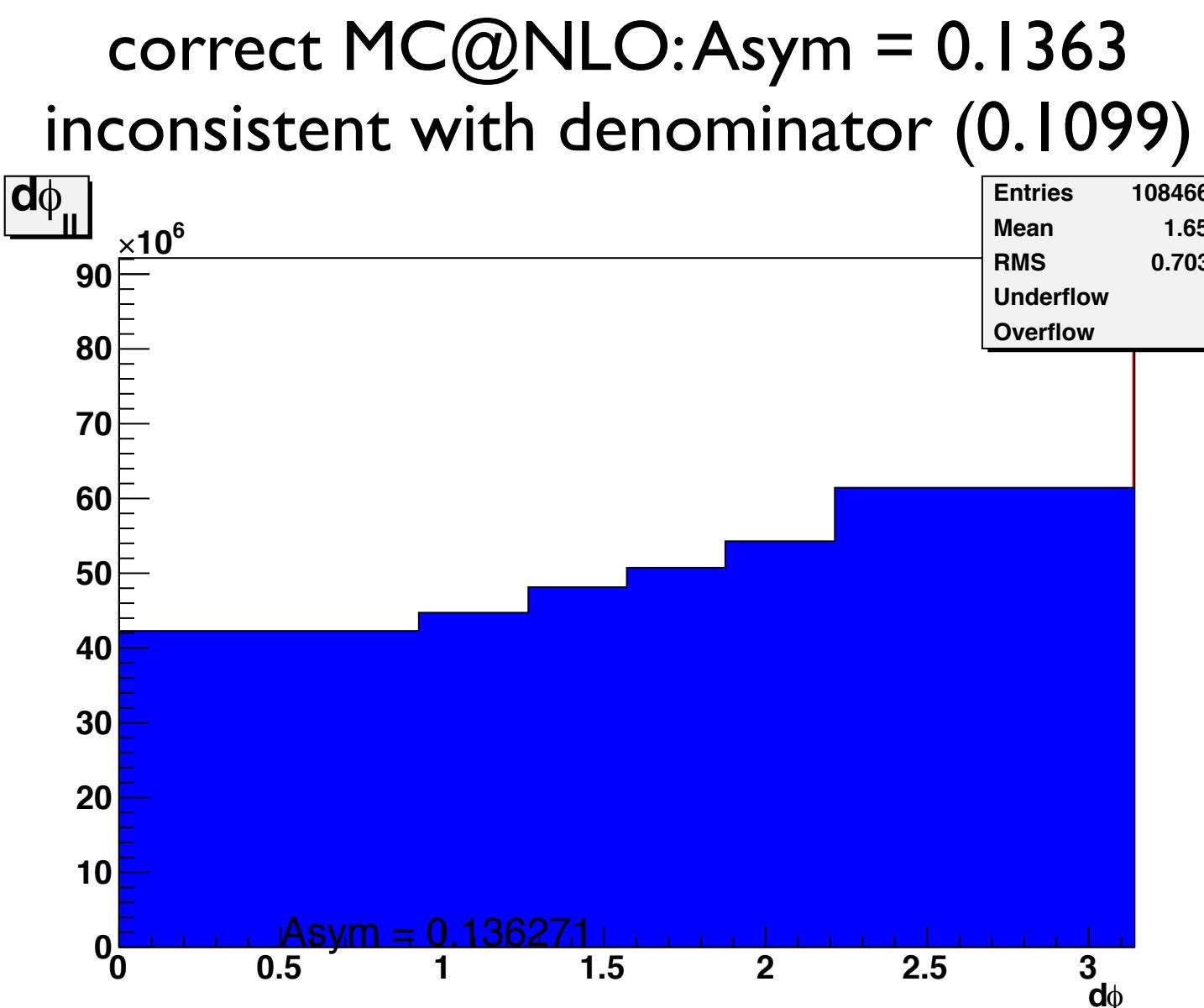
	pt	phi	eta	mass	status	Mother
0	d	0	0	2.317e+04	0.3062	3 proton
1	d_bar	0	0	-2.284e+04	0.3195	3 proton
2	t	63.68	1.623	1.205	171.9	3 d_bar
3	t_bar	51.17	-1.61	2.224	173.2	3 d_bar
4	b	66.2	0.3781	0.1664	4.95	3 t
5	W+	75.75	2.598	0.9704	80.7	3 t
6	b_bar	53.09	0.7425	1.317	4.95	3 t_bar
7	W-	96.17	-2.012	1.18	79.97	3 t_bar
8	tau+	77.74	2.398	0.3998	1.777	3 W+
9	nu_tau	15.45	-2.085	1.959	0	3 W+
10	tau-	34.89	-2.65	0.1594	1.777	3 W-
11	nu_tau_bar	71.24	-1.716	1.403	0	3 W-
12	c_bar	0	0	2.348e+04	1.541	3 c_bar
13	s_bar	0	0	-2.278e+04	0.5	3 s_bar
14	d	0	0	2.284e+04	0.3202	3 d
15	g	0	0	-2.276e+04	0.75	3 g

	pt	phi	eta	mass	status	Mother
0	g	0	0	2.438e+04	0.7071	3 proton
1	g	0	0	-2.278e+04	0.75	3 proton
2	t	11.35	-0.1939	5.364	138.2	3 g
3	t_bar	44.23	-1.078	2.881	172.5	3 g
4	b	36.52	-1.097	3.555	4.943	3 t
5	W+	30.34	1.749	3.635	83.34	3 t
6	b_bar	56.58	-1.804	0.6503	4.95	3 t_bar
7	W-	37.57	0.4422	2.938	69.68	3 t_bar
8	tau+	44.22	2.974	2.522	1.777	3 W+
9	nu_tau	44.34	0.5314	2.614	0	3 W+
10	tau-	28.76	1.864	1.689	1.777	3 W-
11	nu_tau_bar	43.8	-0.2647	2.548	0	3 W-



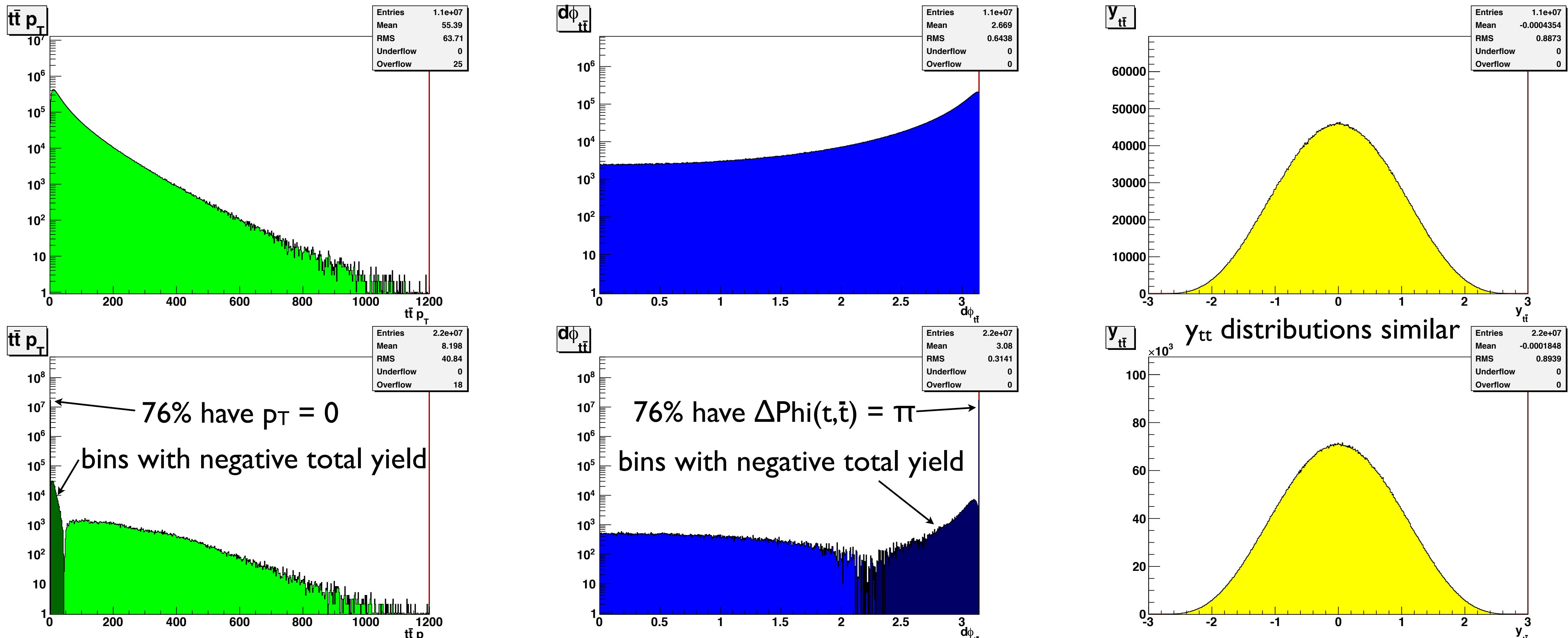
Comparison at LHE level (excluding taus)

- Also tried to compare at LHE level (results taken directly from LHE files)
- Powheg result consistent with denominator on previous slide
- MC@NLO result inconsistent
- Powheg and MC@NLO results also inconsistent with each other
- Look in more detail at powheg vs MC@NLO at LHE level (next slide)



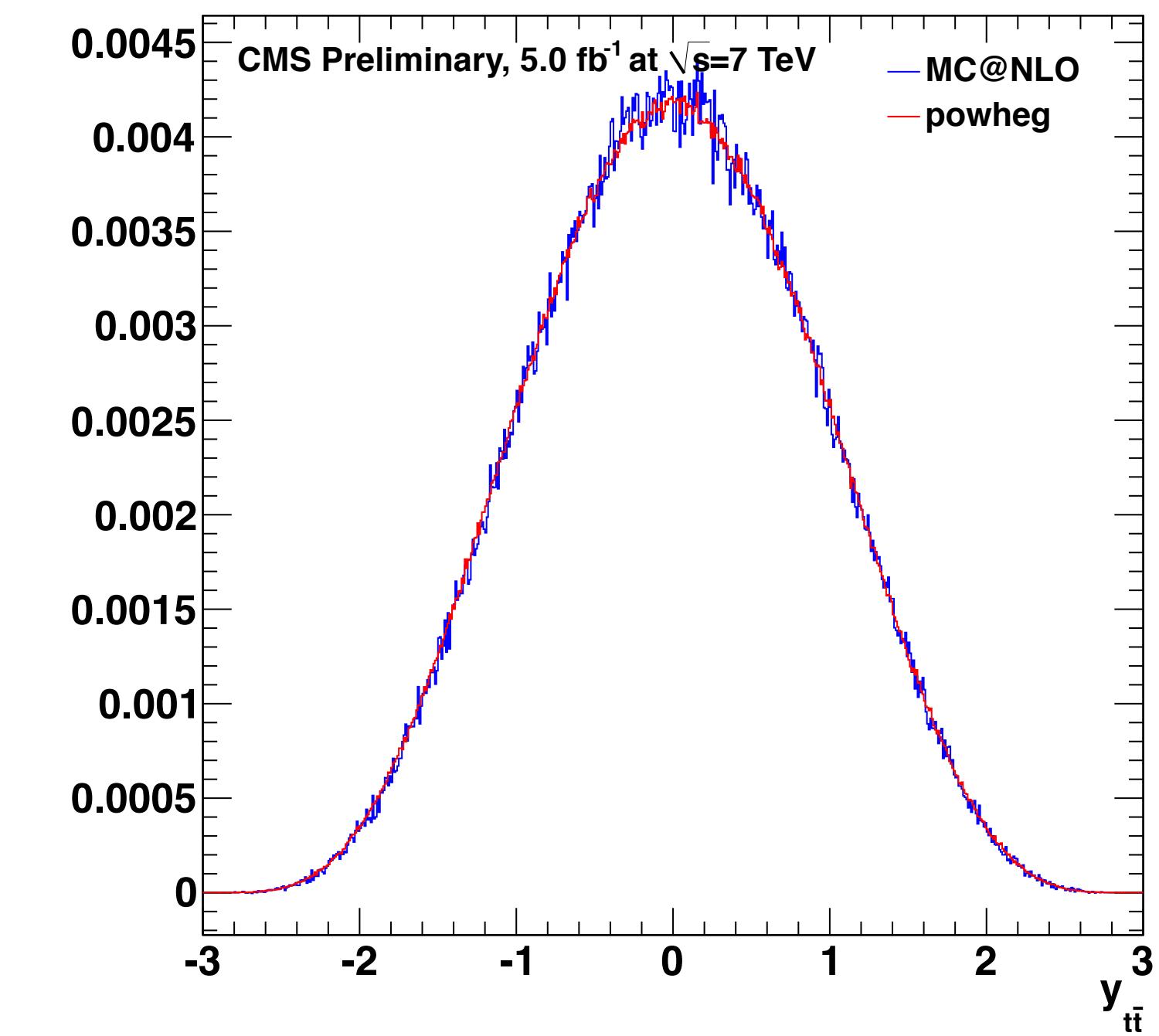
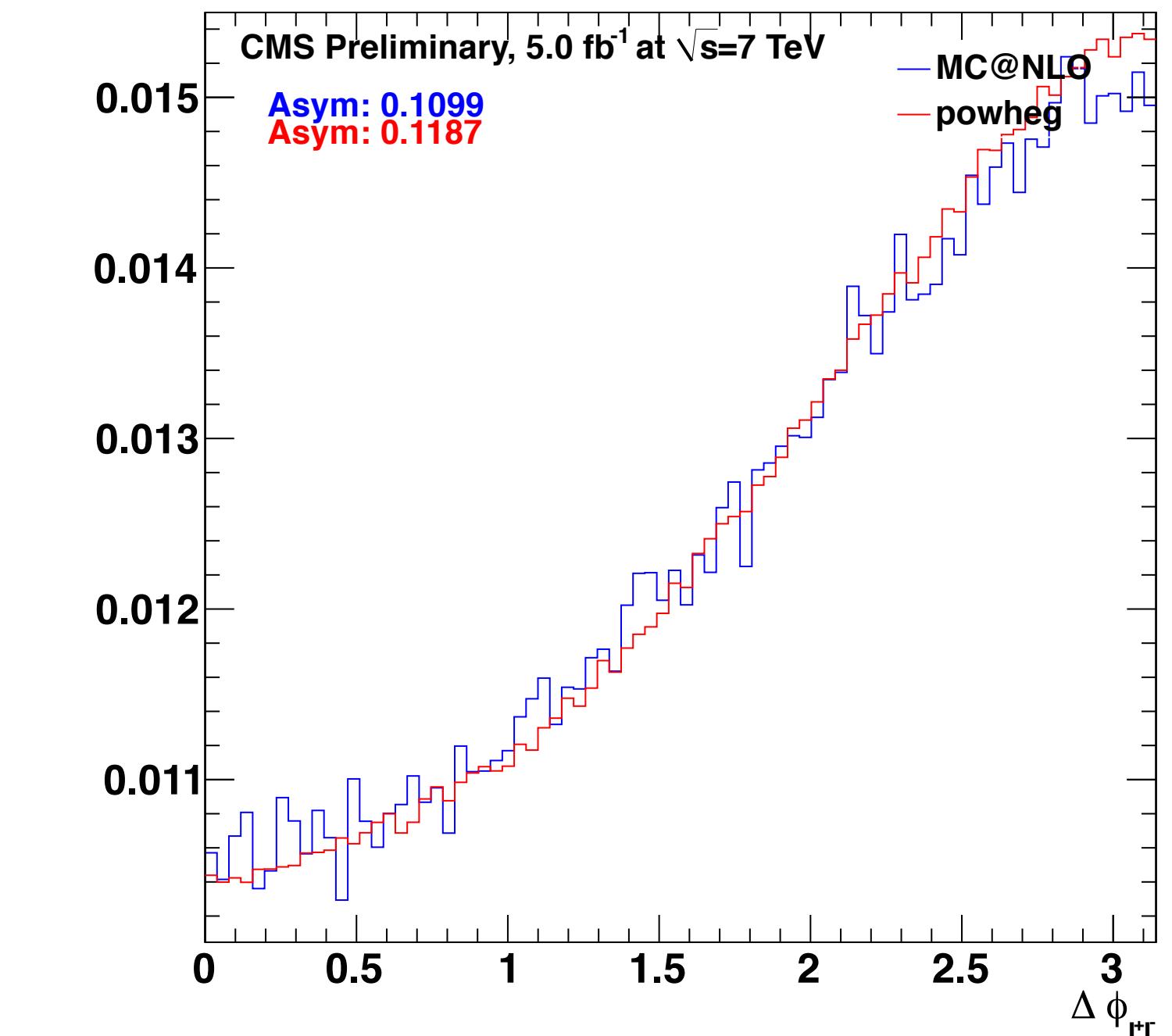
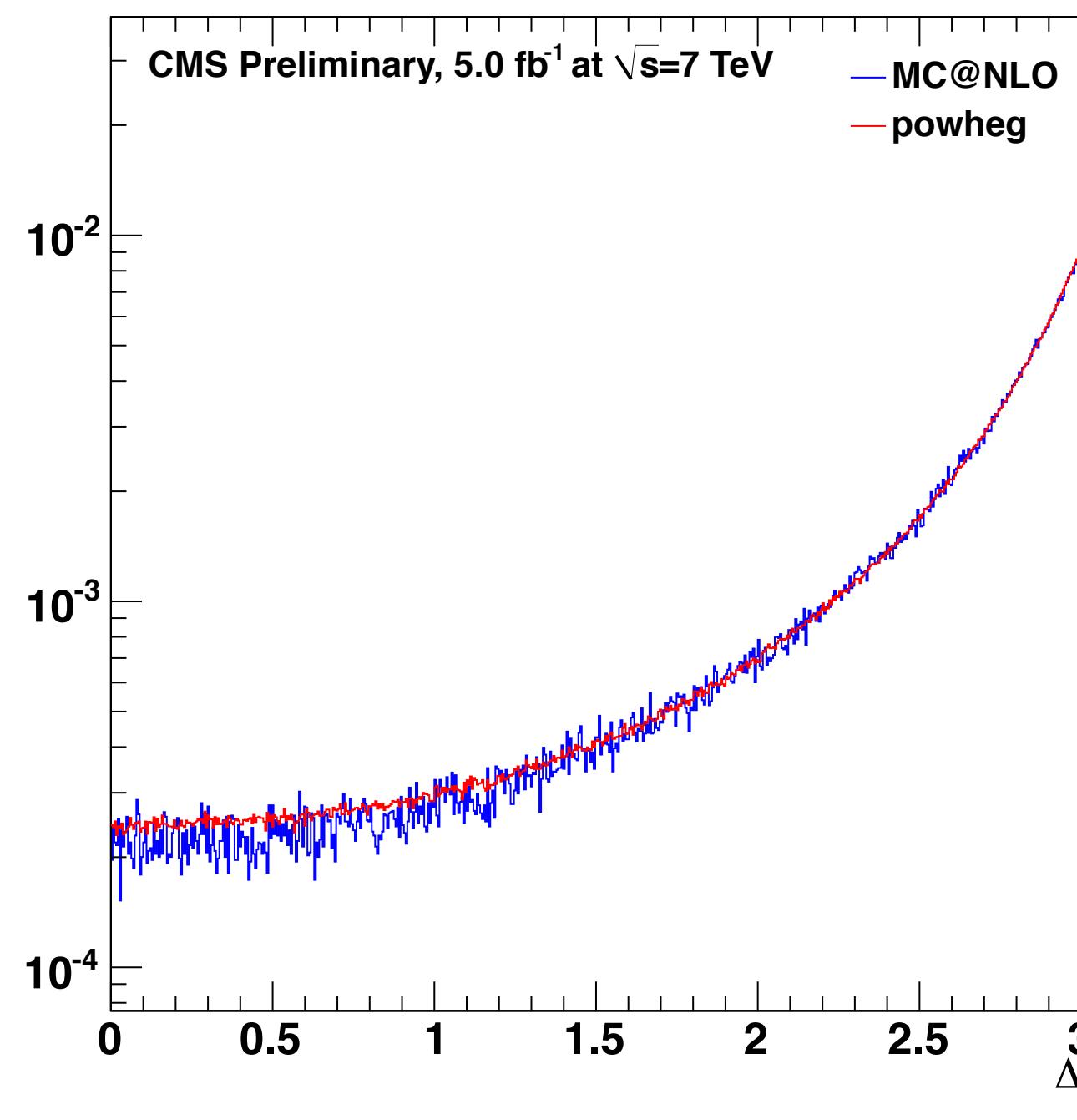
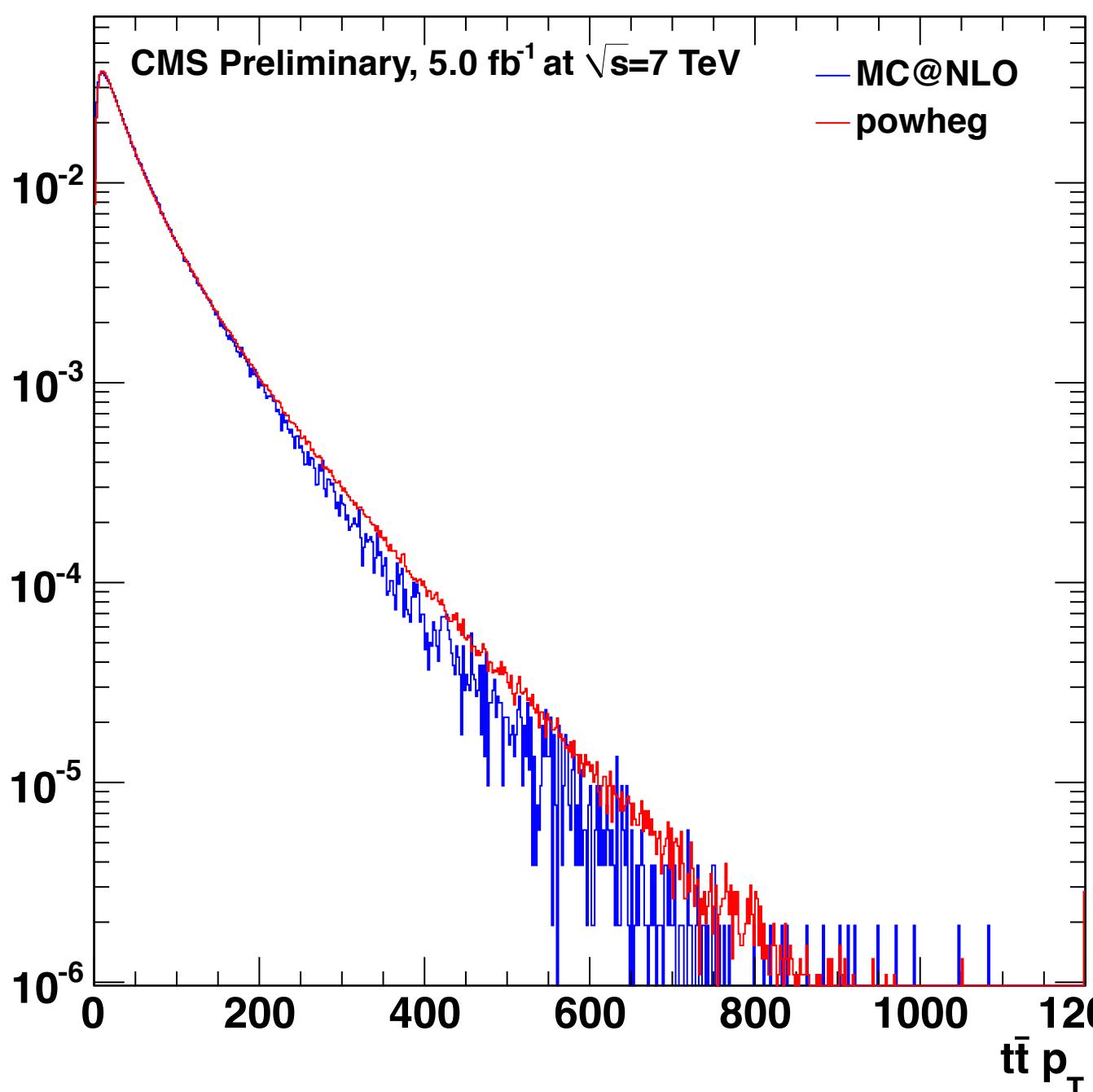
ttbar system at LHE level in powheg and MC@NLO

- ttbar p_T and $\Delta\phi(t, \bar{t})$ distributions very different in powheg (top row) and MC@NLO (bottom row)
- 76% of MC@NLO events have ttbar $p_T = 0$ (zoom in to see very narrow bin at 0), and some bins have unphysical negative total (denoted by darker shading)
- Conclude that MC@NLO LHE distributions are not comparable to powheg LHE distributions (nor to denominator level distributions). Is the discrepancy caused by Herwig adjusting the ttbar p_T after IFSR?



denominator level comparison

- **powheg** and **MC@NLO** (both without taus) ttbar system distributions look much more similar at denominator level (below)
- Lepton $\Delta\phi$ distributions also pretty compatible at denominator level (right, note these are the same distributions as shown on slide 5 but with finer binning)
- It looks like the remaining discrepancies here are due to real differences between the two MCs
- Need to work on selecting leptonically decaying taus from MC@NLO
 - but the problem of lost spin correlations in tau decays in MC@NLO would still remain

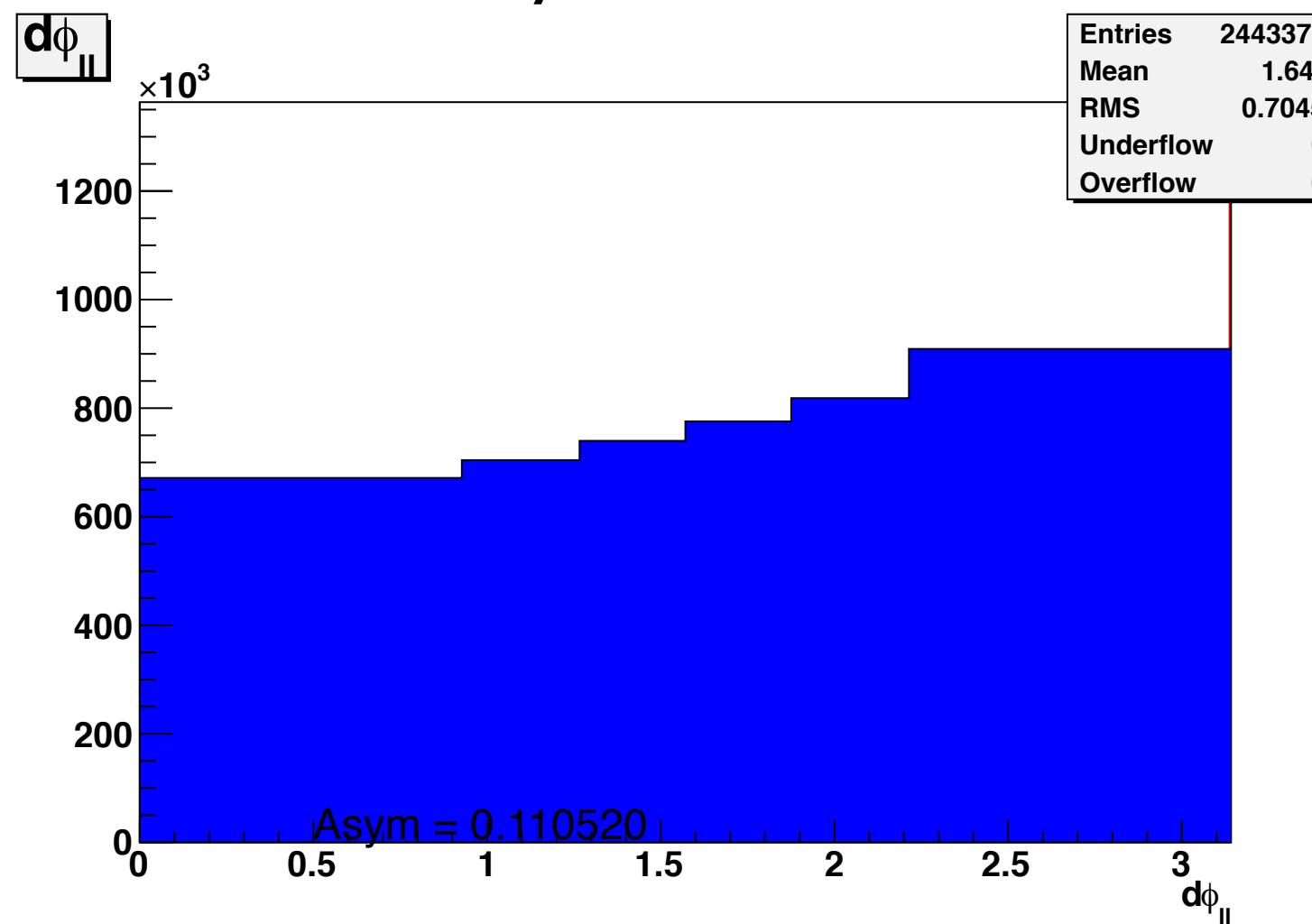


Backup

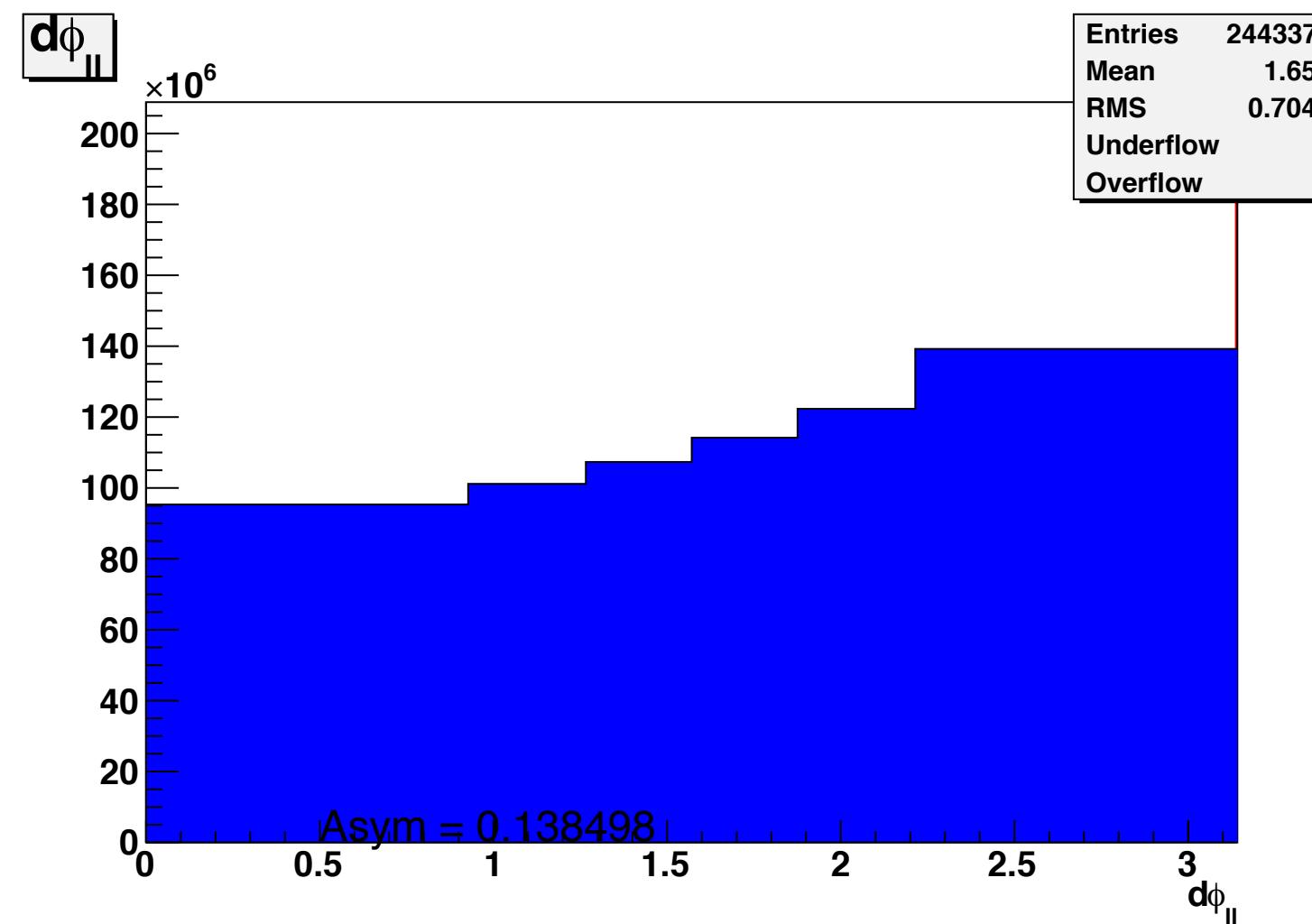
Comparison at LHE level (including taus)

- Same as slide 6, but now including taus; the difference is negligible at LHE level

MC@NLO, all weights set positive:
Asym = 0.1105



correct MC@NLO: Asym = 0.1385



powheg: Asym = 0.1206
consistent with denominator (0.1186)

